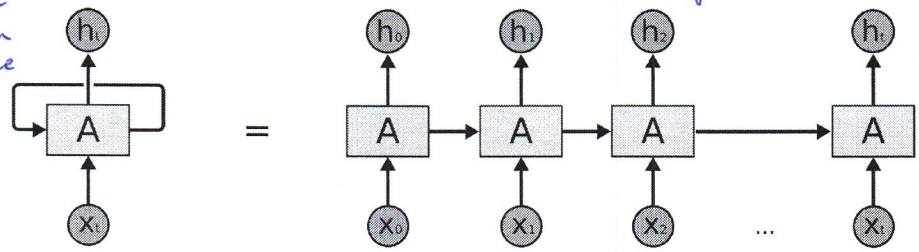
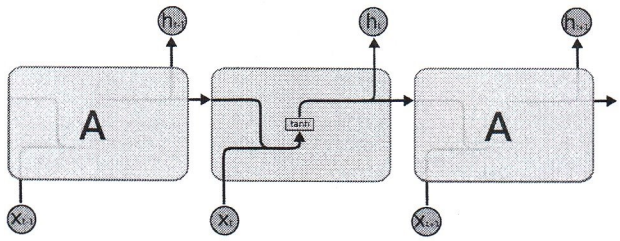
Recurrent Neural Networks (RNNs)

neural net that allows the implementation of memory in learning

(used to model the temporal correlation among a sequence of samples)

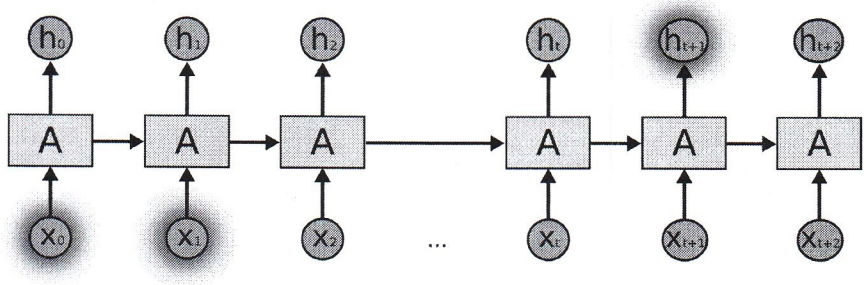




$$a_h^t = \sum_{i=1}^{I} w_{ih} x_i^t + \sum_{h'=1}^{H} w_{h'h} b_{h'}^{t-1}$$

$$b_h^t = \theta_h(a_h^t)$$

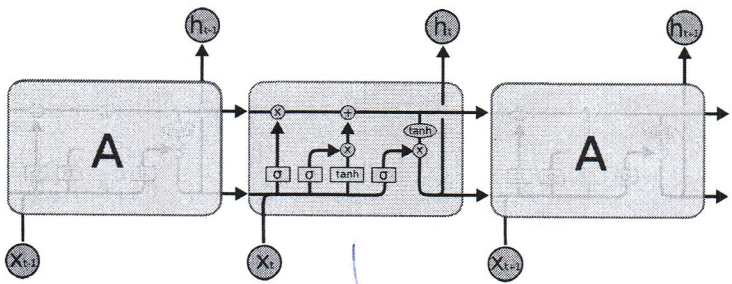
Recurrent Neural Networks (RNNs)



Difficulties in learning long-term dependences..

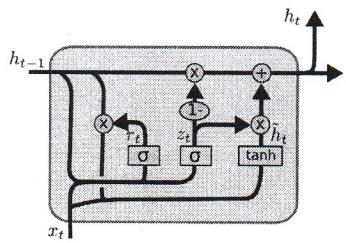
Recurrent Neural Networks (RNNs)

Long Short-Term Memory (LSTM)
Hochreiter & Schmidhuber (1997)

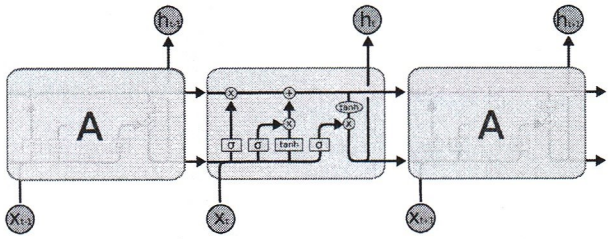


we learn the filters that activate the gates

Gated Recurrent Unit (GRU)
Cho, et al. (2014)



Long Short-Term Memory (LSTM)



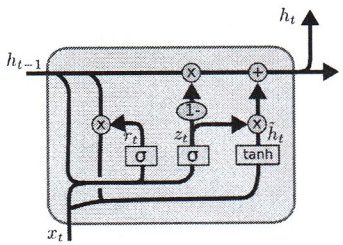
https://www.tensorflow.org/api_docs/python/tf/keras/layers/LSTM

tf.keras.layers.LSTM

```
LSTM(
    units,
    activation='tanh',
    recurrent_activation='sigmoid',
    use_bias=True,
    kernel_initializer='glorot_uniform',
    recurrent_initializer='orthogonal',
    bias_initializer='zeros',
    unit_forget_bias=True,
    kernel_regularizer=None,
    recurrent_regularizer=None,
    bias_regularizer=None,
    activity_regularizer=None,
    kernel_constraint=None,
    recurrent_constraint=None,
    bias_constraint=None,
    dropout=0.0,
    recurrent_dropout=0.0,
    implementation=2,
    return_sequences=False,
    return_state=False,
    go_backwards=False,
    stateful=False,
    time_major=False,
    unroll=False,
    **kwargs)
```

Two versions, both good, choosing which one is choosing an hyperparam.

Gated Recurrent Unit (GRU)

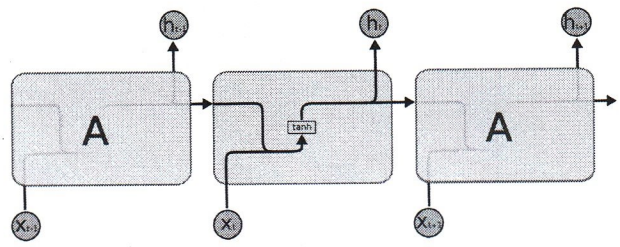


https://www.tensorflow.org/api_docs/python/tf/keras/layers/GRU

tf.keras.layers.GRU

```
GRU(
    units,
    activation='tanh',
    recurrent_activation='sigmoid',
    use_bias=True,
    kernel_initializer='glorot_uniform',
    recurrent_initializer='orthogonal',
    bias_initializer='zeros',
    kernel_regularizer=None,
    recurrent_regularizer=None,
    bias_regularizer=None,
    activity_regularizer=None,
    kernel_constraint=None,
    recurrent_constraint=None,
    bias_constraint=None,
    dropout=0.0,
    recurrent_dropout=0.0,
    implementation=2,
    return_sequences=False,
    return_state=False,
    go_backwards=False,
    stateful=False,
    unroll=False,
    time_major=False,
    reset_after=True,
    **kwargs)
```


Simple RNN



https://www.tensorflow.org/api_docs/python/tf/keras/layers/SimpleRNN

tf.keras.layers.SimpleRNN

```
SimpleRNN(
    units,
    activation='tanh',
    use_bias=True,
    kernel_initializer='glorot_uniform',
    recurrent_initializer='orthogonal',
    bias_initializer='zeros',
    kernel_regularizer=None,
    recurrent_regularizer=None,
    bias_regularizer=None,
    activity_regularizer=None,
    kernel_constraint=None,
    recurrent_constraint=None,
    bias_constraint=None,
    dropout=0.0,
    recurrent_dropout=0.0,
    return_sequences=False,
    return_state=False,
    go_backwards=False,
    stateful=False,
    unroll=False,
    **kwargs)
```